MOTOROLA INC. COMMUNICATIONS DIVISION • **INSTRUCTION MANUAL**

MOTOROLA test equipment

frequency calibrator

MODEL S1068A

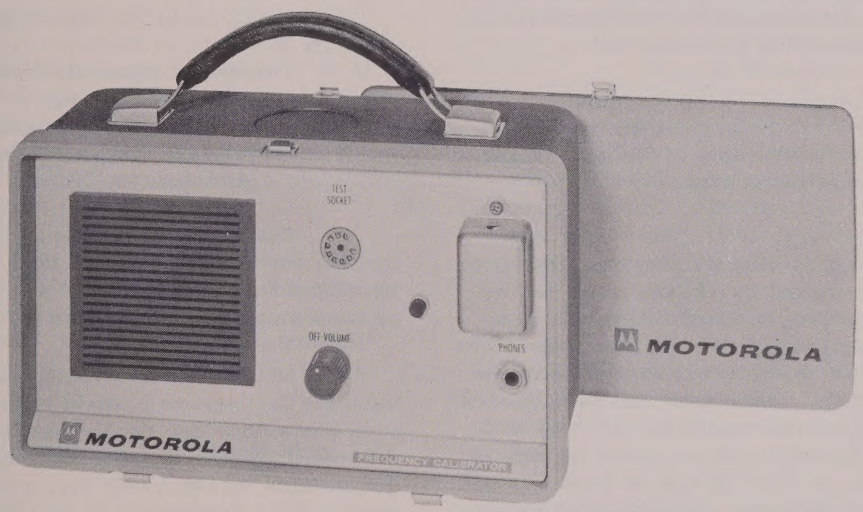
PRINTED IN U.S.A.

68P81018A55-A

MOTOROLA

FREQUENCY CALIBRATOR

MODEL S1068A



AEPD-9242-O(CE2286-G14)

MOTOROLA INC. COMMUNICATIONS DIVISION

Engineering Publications *4501 W. Augusta Blvd.* *Chicago 51, Illinois*

Copyright 1963 by Motorola, Inc.
Printed in U. S. A.

12/5/63-UP

68P81018A55
Issue - A

WARRANTY

Motorola instrument equipment other than tubes, fuses, vibrators, and batteries is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

Tubes and vibrators carry their own standard manufacturer's warranty of 90 days or 1000 hours, whichever first occurs.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

Motorola Communication &
Electronics, Inc.
Parts & Service Department
4910 West Flournoy Street
Chicago 44, Illinois

Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

FOREWORD

CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have received damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

68P81009A95-O

NOMENCLATURE

Motorola radio equipment is specifically identified by the model number on the nameplate.

NOTE

Be sure to use the entire model number when making inquiries about your equipment.

Identifiers have been assigned to chassis and kits. Use these identifiers when requesting information or ordering replacements.

PRODUCTION CHANGES

When production and engineering changes are incorporated into the equipment, a revision numeral is assigned to the chassis or kit affected.

Typical Example:
The Model S1068A becomes S1068B with the first revision.

This chassis number complete with revision numeral, if any, is stamped on the chassis at the time of production. The revision numeral becomes an integral part of the chassis identifier.

A schematic diagram number complete with its issue letter is also stamped on each chassis. This establishes direct correlation between the chassis and its schematic. The schematic issue is advanced each time a change occurs in the chassis.

INSTRUCTION MANUAL REVISIONS

Changes which occur after an instruction manual is printed are described in the Instruction Manual Revision. These bulletins give the reader complete information on the change including pertinent parts listing data.

REPLACEMENT PARTS ORDERING

Motorola maintains parts and service depots and authorized service stations strategically located throughout the country. These facilities are fully equipped to give the finest service.

When ordering replacement parts, the complete number identification of the item must be used whether it be a component, kit or complete chassis. This will fix proper identification and insure receipt of the desired item. Complete number identification should also be used when requesting equipment information.

REPAIR AND/OR RECALIBRATION

It is suggested that the instrument be returned to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

For repair and/or recalibration. Before shipping the instrument notify the Parts and Service Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via Truck, Railway Express, Air Freight, or Air Express.

CAREFUL USE OF THE INSTRUCTION MANUAL AND THE MANY SUGGESTIONS CONTAINED IN IT WILL FURTHER INSURE PROPERLY INSTALLED AND MAINTAINED RADIO EQUIPMENT.

THE EQUIPMENT DESCRIBED IN THIS MANUAL IS MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING MOTOROLA U.S. PATENTS:

	2,608,648	2,743,144	2,833,994	2,963,577
RE-24,110	2,608,649	2,743,361	2,834,879	2,966,585
RE-24,815	2,626,384	2,750,451	2,835,794	2,968,739
2,404,359	2,637,782	2,759,052	2,852,730	2,974,221
2,439,408	2,650,333	2,759,103	2,860,239	2,984,740
2,439,412	2,662,942	2,770,721	2,883,521	2,994,844
2,472,021	2,688,059	2,777,950	2,888,652	3,009,115
2,524,300	2,691,094	2,784,263	2,899,547	3,014,127
2,524,534	2,691,560	2,799,001	2,901,601	3,027,454
2,547,023	2,699,425	2,799,010	2,912,573	3,027,455
2,547,025	2,705,281	2,808,507	2,918,571	3,039,081
2,547,027	2,731,555	2,809,236	2,924,705	3,041,550
2,566,759	2,738,466	2,810,068	2,925,562	3,048,659
2,583,032	2,740,891	2,830,200	2,938,082	3,048,747
2,602,842				3,059,184

Other U.S. Patents Pending

CONTENTS

SECTION	NUMBER
Specifications	vi
Introduction	1
Description	1
Theory of Operation	1
Calibration	2
Recalibration of the Frequency Calibrator	3
Servicing	3
Block Diagram	4
Parts Location, Rear of Chassis	4
Parts Location, Main Printed Circuit Board	5
Parts Location: Power Supply, Oscillator and Amplifier	5
Schematic Diagram	7

GUARANTEED PERFORMANCE SPECIFICATIONS

MODEL	S1068A Frequency Calibrator
FREQUENCIES	11 as follows: 13.1475 13.1625 13.1500 13.1650 13.1525 13.1675 13.1550 13.1700 13.1575 13.1725 13.1600
CALIBRATION ACCURACY	
at +25°C	$\pm 1 \times 10^{-6}$ (0.0001%)
at +20°C and +30°C	$\pm 2 \times 10^{-6}$ (0.0002%)
TEMPERATURE OPERATING RANGE	+10°C to +40°C
OSCILLATOR CHARACTERISTICS	
3.29 mc Crystal Oscillator	
Frequency Adjustment Range	$\pm 2 \times 10^{-6}$ (at +25°C)
Long Term Stability	Less than $\pm 3 \times 10^{-8}$ per month of aging
2.5 kc Oscillator (nonadjustable)	
Accuracy	$\pm 50 \times 10^{-6}$ (0.005%)
Long Term Stability	Less than $+100 \times 10^{-6}$ per year of aging
Temperature Characteristics	$\pm 750 \times 10^{-6}$ (-20°C to +75°C)
AUDIO OUTPUT	Speaker, and Phone Jack
AC INPUT REQUIREMENTS	117 VAC -10%, 50-60 cps
POWER CONSUMPTION	5 watts (approximately)
CIRCUITRY	Germanium and silicon transistors; transistor and zener diode regulation.
DIMENSIONS	10-1/4" wide x 7" high x 6" deep
WEIGHT	8 lbs. 4 oz.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

1. INTRODUCTION

The Model S1068A Frequency Calibrator is a specialized instrument which provides an accurate, rapid, and simple method of calibrating the crystal oscillators of transmitter-receivers used in car telephones manufactured by Motorola. Transmitter-receivers used in the car telephone system have a multi-channel capability with up to 11 oscillators provided for one equipment; since channel spacing is only 30 kc and oscillator frequency multiplication is 12, oscillator frequencies themselves are separated by only 2.5 kc. Thus the use of conventional frequency measuring and calibrating equipment for oscillator calibration would result in a complicated and time-consuming process. The frequency calibrator provides accurate calibration of each oscillator within about 30 seconds, which includes both transmitter and receiver control frequencies since both frequencies are synthesized from the same oscillator crystal for any one channel in the Car Telephone System.

2. DESCRIPTION

The frequency calibrator is housed in a portable aluminum case with a cover. The front panel is provided with an integral power switch and volume control (marked OFF-VOLUME); a TEST SOCKET (into which is plugged the oscillator to be calibrated); a PHONES jack, a loudspeaker, and the control crystal in its own ventilated housing.

The frequency calibrator uses a reference frequency and selected harmonics; the correct harmonic is automatically selected and heterodyned with the output of the oscillator to be adjusted. In correct adjustment of the plug-in oscillator results in an audible beat note which is heard from the speaker, or from the speaker and a headset which may be plugged into the PHONES jack. Zero beat between the two lowest frequency beat notes indicates correct oscillator adjustment. The PHONES jack permits using a headset in cases of high ambient noise level; any low impedance headphones may be used.

3. THEORY OF OPERATION

The frequency calibrator block diagram illustrates the signal flow and the relation of circuits in the frequency calibrator.

a. Oscillator and Buffer Amplifier

The oscillator and buffer-amplifier stages generate and amplify the basic reference frequency. This basic reference frequency of 3.29 mc is generated by the crystal-controlled oscillator. Drift due to crystal aging is held to a minimum by mounting the crystal in an evacuated glass case. The specially processed AT-cut quartz crystal has a nominal Q in excess of one million. The temperature characteristics of the master oscillator and its crystal are correlated with those of the telephone system transmitter-receiver oscillators; this precaution greatly reduces the effects of temperature variations during calibration.

Amplification and a proper load for the 3.29 mc oscillator is furnished by the buffer-amplifier stage which follows the oscillator.

b. Multiplier

In the multiplier, the reference frequency is multiplied four times to provide a center test frequency of 13.1600 mc. This signal is then filtered through a double-tuned LC network and is then fed to the spectrum generator.

c. 2.5 kc Oscillator

The 2.5 kc oscillator consists of a tuning fork-controlled transistorized circuit housed in its own seamless steel can with plug-in octal base. The stability of this oscillator is sufficiently high that, from a frequency standpoint, drift is negligible. The output of this oscillator is also fed into the spectrum generator. The tuning fork oscillator generates a faint hum which is audible when the loudspeaker volume is turned down.

d. Spectrum Generator

The spectrum generator mixes the 13.1600 mc output of the multiplier with the output of the 2.5 kc generator to produce 10 discrete output signals at 2.5 kc increments and decrements from 13.1600 mc, which, with the 13.1600 mc center frequency, comprise the 11 oscillator channels. The 11-channel output of the spectrum generator is fed to the detector.

e. 13 MC Amplifier

The 13 mc amplifier not only amplifies the signal from the oscillator under test but also

serves as the proper load for it and thus provides the same external effect on oscillator operation that occurs under operating conditions.

f. Detector

In this circuit, the outputs of the spectrum generator are mixed with the output from the 13 mc amplifier to produce difference (beat) frequencies. Since the frequency of the plug-in oscillator can be varied only about 1 kc, the proper reference frequency is automatically selected because the spacing between reference frequencies is 2.5 kc.

g. Low Pass Filter and Audio Amplifier

The low pass filter and audio amplifier circuit filters out all beat frequencies except those below approximately 600 cps, and amplifies the latter to drive the Schmitt trigger circuit.

h. Schmitt Trigger

The Schmitt trigger produces a constant amplitude square wave output at the same frequency as the sine or square wave input. A square wave output is necessary so that at frequencies at which a sine wave tone is inaudible (below 10 cps), a beat will still be heard in the speaker (or headset).

4. CALIBRATION

NOTE

Both the module (channel element) to be tested and the frequency calibrator should be allowed to stabilize a ambient room temperature for at least one-half hour before calibration begins. For accurate frequency calibration, the module should be calibrated at 25°C (77°F) ambient temperature, or as close to 25°C (77°F) as possible. Before commencing calibration, it is advisable to turn off the transmitter if it is in the vicinity of the frequency calibrator. This will avoid the possibility of r-f pickup by the calibrator and the chance of interference with the alignment procedure.

Calibration procedure for the oscillator modules (channel elements) is outlined in the following steps:

1. Plug the frequency calibrator line cord into a 117 v a-c power source.

2. Turn the unit on using the OFF-VOLUME control. The red indicator lamp should light, which shows the unit is powered. (There will be a short noise burst from the speaker, which is normal.)

3. Turn the OFF-VOLUME control clockwise about a quarter turn.

4. Plug the module to be calibrated into the TEST SOCKET and allow fifteen seconds for it to stabilize before adjusting the trimmer capacitor; this capacitor is reached through the adjustment hole in the top of the module.

NOTE

For best accuracy in calibration, handle the modules with the fingertips only, and as little as possible. Hand heat can upset the correlation between the temperatures of the module and the control oscillator.

5. Insert a screwdriver into the hole in the top of the module and adjust the trimmer capacitor until zero beat is obtained. The tone of the sound should get lower as this point is approached. Slowly continue turning in the same direction until the beat disappears and is heard again. Then turn the capacitor back until the zero beat point is reached.

NOTE

1. It is possible to get dead spots at the extreme out-of-zero points. However, some noise will be evident, and the tone of the output on either side of this point will be high.

2. Because the trimmer capacitor is symmetrical, two true zero beats can be obtained as the capacitor is rotated through 360°; either may be used.

6. If the zero beat point has a tendency to drift, allow some additional time for it to settle and then make a readjustment.

CAUTION

The small case mounted on the upper right section of the front panel houses the control crystal. The holes in the case are ventilation holes to allow the

***CAUTION* (Cont'd)**

control crystal to stabilize at the same temperature as the plug-in modules. These are not adjustment holes. Do not introduce foreign objects into these holes. Do not try to remove the crystal case from the panel.

5. RECALIBRATION OF THE FREQUENCY CALIBRATOR

The frequency calibrator should be recalibrated once a year. Motorola is equipped to provide this service, and it is recommended that the instrument be returned to Motorola for recalibration (see FOREWORD for further information). However, should the user be equipped to perform this adjustment, the following data is provided:

a. Oscillator Data

The reference frequency of the frequency calibrator oscillator is 3.29 mc. This frequency is multiplied four times to give 13.16 mc which is the center frequency of the eleven plug-in modules or channel elements. The temperature characteristics of the crystal used in the reference oscillator are similar to those of the plug-in channel elements. The typical frequency change due to temperature, between 20°C and 30°C, is 0.1 part per million or 1.316 cps per degree centigrade.

The reference oscillator is calibrated at the factory after temperature stabilization in a temperature-controlled chamber (25°C ±0.3°C) to provide an accuracy of 0.01 part per million, or 1×10^{-8}.

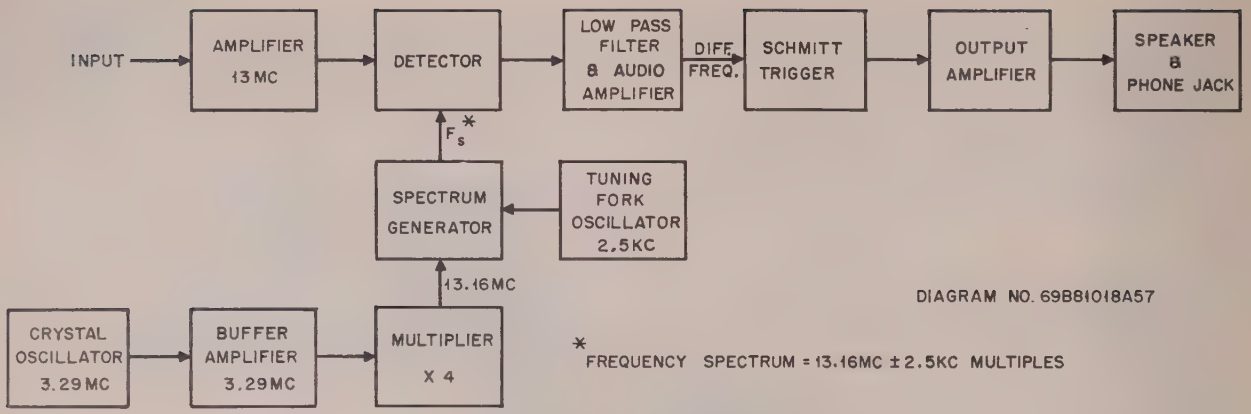
b. Requirements for Recalibration

A counter may be used to calibrate the reference oscillator provided this is done in an ambient temperature of 25° ±0.3°C and the accuracy of the counter is 1×10^{-8} or better; or other methods of equivalent or better accuracy may be used.

6. SERVICING

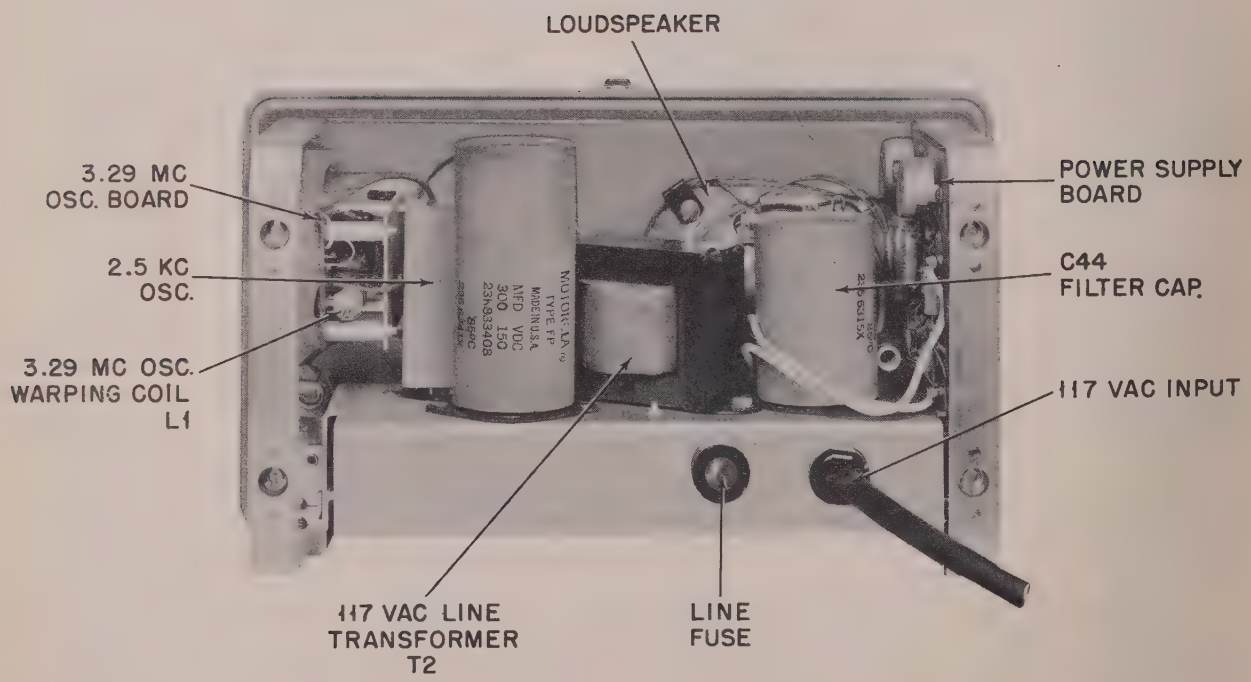
CAUTION

A 150 ohm, 5%, 1/10 watt carbon resistor (R59) is located in the +9.5 volt supply; it functions as a dropping resistor and also as a fuse to protect the zener diode in the power supply. This resistor, which is located at the top of the power supply printed circuit board between the two potentiometers (see Miscellaneous Parts Location phonograph, Motorola No. EPD-9104), will blow in case a shorted channel element is plugged in for calibration. (The power supply is the vertical printed circuit board located near the loudspeaker). If it becomes necessary to replace this resistor, be sure that the replacement is rated at only 1/10 watt.



69B81018A57-O

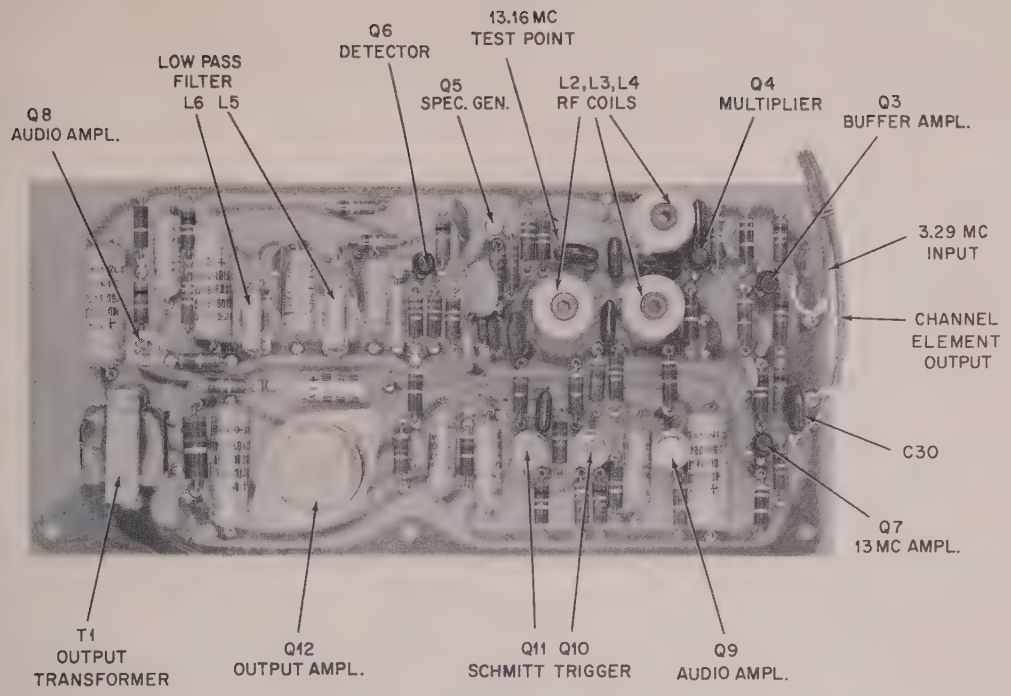
Block Diagram



AEPD-9243-O(CE2286-H14)

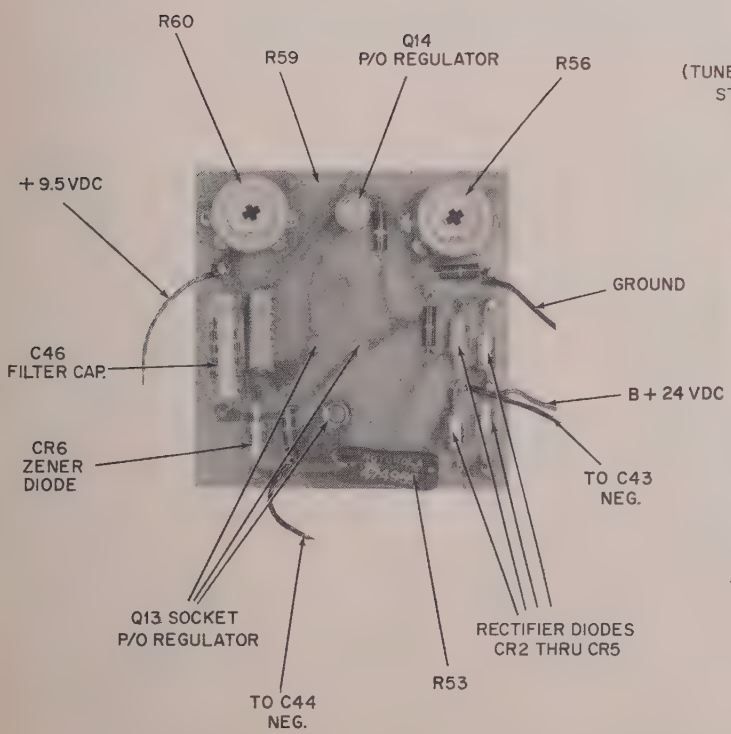
Rear of Chassis
Miscellaneous Parts Location Detail

AEPD-9105-O(CE2286-F12)

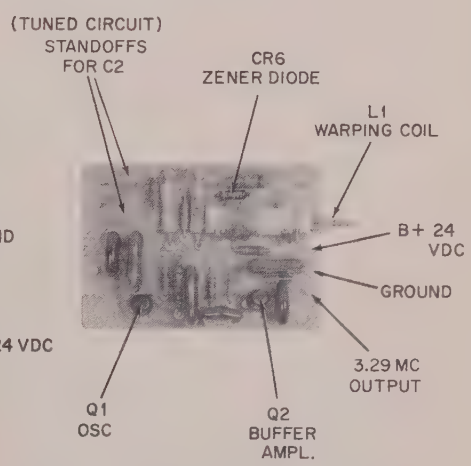


Main Printed Circuit Board
Miscellaneous Parts Location Detail

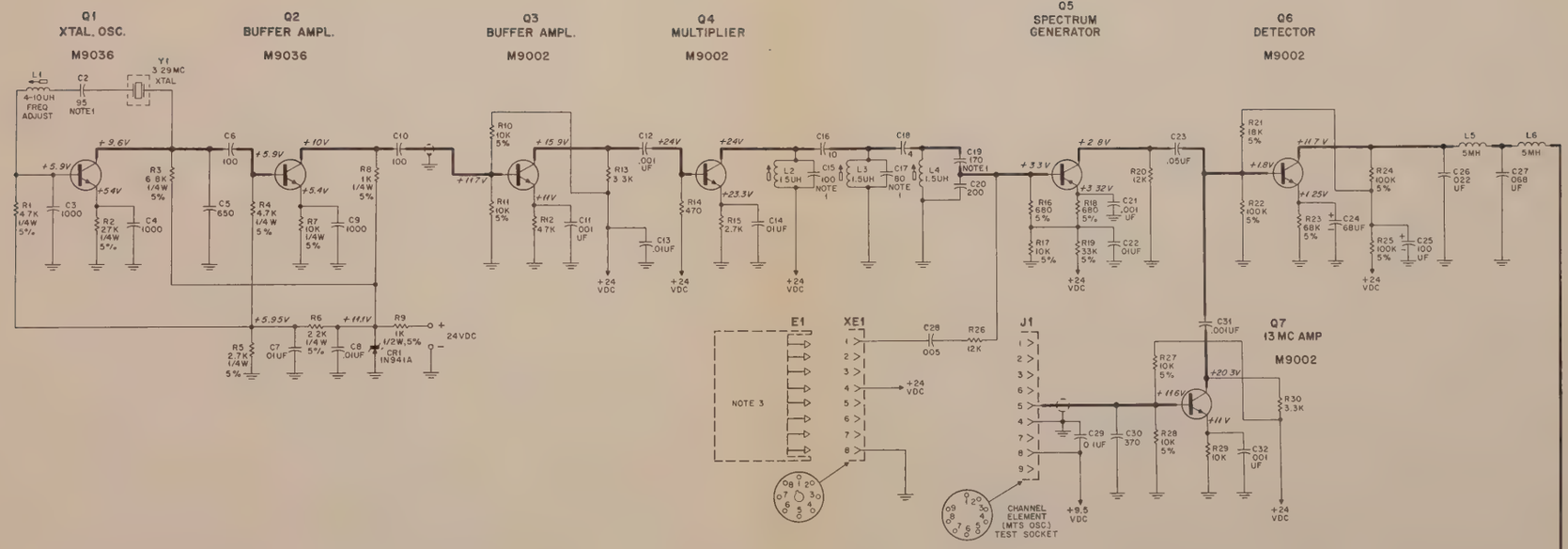
AEPD-9104-O(CE2286-E12)



Power Supply Printed Circuit Board



3.29 MC Oscillator And Buffer
Amplifier Printed Circuit Board



Schematic Diagram
Motorola No. 63E81018A56-B

Frequency Calibrator

68P81018A55-A